Claims

1. A method of ion texturing a noncrystalline surface of a layer of a cubic structure material, the method comprising:

exposing the noncrystalline surface to at least two ion beams to texture the noncrystalline surface and form a biaxially textured surface of the cubic structure material,

wherein the at least two ion beams impinge on the surface of the noncrystalline layer at a first angle relative to a perpendicular to the noncrystalline surface, the at least two ion beams being disposed relative to each other at a second angle around the perpendicular to the noncrystalline surface so that a crystal plane of the biaxially textured surface is oriented perpendicular to the biaxially textured surface.

2. The method of claim 1, wherein the cubic structure material comprises YSZ and the first angle is from about 51° to about 59°.

3. The method of claim 2, wherein the first angle is about 55°.

4. The method of claim 1, wherein the cubic structure material comprises YSZ and the YSZ is at a temperature of from about room temperature to about 900°C during ion texturing.

5. The method of claim 4, wherein the first angle is about 55°.

6. The method of claim 1, wherein the cubic structure material comprises a material selected from the group consisting of rock salt structure materials and fluorite structure materials.

7. The method of claim 1, wherein the cubic structure material comprises a material selected from the group consisting of MgO, TiN, CaO, SrO, ZrO, BaO, YSZ and ceria.

8. The method of claim 1, wherein the second angle is about 180°.

9. The method of claim 1, wherein the second angle is about 90°.

10. The method of claim 1, further comprising disposing a layer of a second material on the biaxially textured surface of the cubic structure material, the second material being selected from the group consisting of superconductor materials, precursors of superconductor materials, materials that are chemically compatible with superconductor materials, and materials that are chemically compatible with precursors of superconductor materials.

11. The method of claim 10, wherein the second material is chemically compatible with BaF_2.

12. The method of claim 10, wherein the second material is selected from the group consisting of ceria, $LaAlO_3$ and $SrTiO_3$.

13. The method of claim 10, wherein the second material is selected from the group consisting of YBCO and precursors of YBCO.

14. The method of claim 1, wherein biaxially textured surface of the cubic structure material is cube textured.

15. The method of claim 1, further comprising, before exposing the noncrystalline surface to the at least two ion beams, forming the layer of the cubic structure material having the noncrystalline surface by simultaneously depositing the cubic material and exposing the cubic material to at least one ion beam.

16. The method of claim 1, further comprising, after forming the biaxially textured surface, simultaneously depositing more of the cubic material on the biaxially textured surface and exposing the cubic material to at least one ion beam.

17. The method of claim 1, wherein the at least two ion beams simultaneously impinge on the noncrystalline surface.

18. The method of claim 1, wherein the at least two ion beams impinge on the noncrystalline surface in sequence.

19. The method of claim 1, wherein the at least two ion beams are two ion beams.

20. The method of claim 1, wherein the at least two ion beams are three ion beams.

21. The method of claim 1, wherein the at least two ion beams are four ion beams.

22. A method of ion texturing a noncrystalline surface of a layer of a material, the method comprising:

exposing the noncrystalline surface to at least two ion beams to texture the noncrystalline surface and form a textured surface of the material,

wherein a first ion beam of the at least two ion beams impinges on the surface at a first angle relative to the perpendicular to the noncrystalline surface, a second ion beam of the at least two ion beams impinges on the surface of the noncrystalline layer at a second angle relative to a perpendicular to the noncrystalline surface, the at least two ion beams being disposed relative to each other at a third angle so that a crystal plane of the biaxially textured surface is oriented perpendicular to the biaxially textured surface.

23. The method of claim 22, wherein the at least two ion beams are two ion beams.

24. The method of claim 22, wherein the at least two ion beams are three ion beams.

25. The method of claim 22, wherein the at least two ion beams are four ion beams.

26. The method of claim 22, wherein the at least two ion beams simultaneously impinge on the noncrystalline surface.

27. The method of claim 22, wherein the at least two ion beams impinge on the noncrystalline surface in sequence.

28. The method of claim 22, further comprising, before exposing the noncrystalline surface to the at least two ion beams, forming the layer of the material having the noncrystalline surface by simultaneously depositing the material and exposing the material to at least one ion beam.

29. The method of claim 22, further comprising, after forming the biaxially textured surface, simultaneously depositing more of the material on the textured surface and exposing the material to at least one ion beam.

30. The method of claim 22, further comprising disposing a layer of a second material on the textured surface of the material, the second material being selected from the group consisting of superconductor materials, precursors of superconductor materials, materials that are chemically compatible with superconductor materials, and materials that are chemically compatible with precursors of superconductor materials.

31. The method of claim 30, wherein the second material is chemically compatible with BaF_2.

32. The method of claim 30, wherein the second material is selected from the group consisting of ceria, $LaAlO_3$ and $SrTiO_3$.

33. The method of claim 30, wherein the second material is selected from the group consisting of YBCO and precursors of YBCO.

34. The method of claim 30, wherein the material is at an exposure temperature during exposure to the at least two ion beams, the exposure temperature being less than a crystallization temperature of the material.

35. The method of claim 34, wherein the exposure temperature is less than about one third of the crystallization temperature of the material.

36. The method of claim 22, wherein the textured surface is biaxially textured.

37. The method of claim 22, wherein the textured surface is cube textured.

38. The method of claim 22, wherein the material is selected from the group consisting of cubic structure materials and hexagonal structure materials.

39. The method of claim 22, wherein the material is selected from the group consisting of rock salt structure materials and fluorite structure materials.

40. The method of claim 22, wherein an ion flux at the surface of the material is at least about 10 microAmperes per square centimeter.

41. The method of claim 22, wherein the crystal plane is the (001) plane.

42. The method of claim 22, wherein the method textures the material to a depth of less than about 50 nanometers.

43. The method of claim 22, wherein the textured surface has a X-ray phi scan full width at half maximum of less than about 20°.

44. The method of claim 22, wherein the textured surface has a root mean square roughness of less than about 100 angstroms.

45. The method of claim 22, wherein the noncrystalline layer is supported by a substrate.

46. The method of claim 45, wherein the substrate is a nontextured substrate.

47. The method of claim 22, wherein the method is performed in a pressure of less than about 10 millitorr.

48. The method of claim 22, wherein exposure to the ions occurs for a time period of at least about 10 seconds.

49. The method of claim 22, further comprising, after an initial ion exposure, decreasing the temperature while exposing the surface to ions.

50. The method of claim 22, wherein the first angle is different than the second angle.

51. A method, comprising:

exposing a surface of a noncrystalline layer of a first material to at least two ion beams to texture the noncrystalline surface and to form a textured surface of the first material; and

disposing a layer of a second material on the textured surface of the first material, the second material being chemically compatible with a third material selected from the group consisting of superconductors and precursors of superconductors.

52. The method of claim 51, wherein the third material is selected from the group consisting of rare earth metal oxide superconductors and precursors of rare earth metal oxide superconductors.

53. The method of claim 51, wherein the third material is selected from the group consisting of YBCO and precursors of YBCO.

54. The method of claim 51, wherein the third material comprises an acid.

55. The method of claim 51, wherein the third material comprises a halogenated acetic acid.

56. The method of claim 51, wherein the third material comprises trifluoroacetic acid.

57. The method of claim 51, wherein the third material comprises BaF_2.

58. The method of claim 51, wherein the method forms a superconductor article having a critical current density of at least about 5×10^5 Amperes per square centimeter.

59. The method of claim 51, wherein the second material comprises a material selected from the group consisting of ceria, $LaAlO_3$ and $SrTiO_3$.

60. The method of claim 51, wherein the first material is selected from the group consisting of YSZ and nitrides.

61. The method of claim 51, further comprising disposing the third material on a surface of the second material.

62. The method of claim 61, wherein the third material comprises YBCO.

63. The method of claim 61, wherein the third material comprises a precursor of YBCO.

64. A method, comprising:

disposing a noncrystalline layer of a second material on a surface of a first material, the second material being chemically compatible with a third material selected from the group consisting of superconductors and precursors of superconductors; and

exposing a surface of the noncrystalline layer of the second material to at least two ion beams to texture the noncrystalline surface and to form a textured surface of the second material.

65. The method of claim 64, wherein the third material is selected from the group consisting of rare earth metal oxide superconductors and precursors of rare earth metal oxide superconductors.

66. The method of claim 64, wherein the third material is selected from the group consisting of YBCO and precursors of YBCO.

67. The method of claim 64, wherein the third material comprises an acid.

68. The method of claim 64, wherein the third material comprises a halogenated acetic acid.

69. The method of claim 64, wherein the method forms a superconductor article having a critical current density of at least about 5×10^5 Amperes per square centimeter.

70. The method of claim 64, wherein the layer of the first material is noncrystalline.

71. The method of claim 64, wherein the second material comprises a material selected from the group consisting of ceria, $LaAlO_3$ and $SrTiO_3$.

72. The method of claim 64, wherein the first material is selected from the group consisting of YSZ and nitrides.

73. The method of claim 64, further comprising disposing the third material on a surface of the second material.

74. The method of claim 73, wherein the third material comprises a rare earth metal oxide.

75. The method of claim 73, wherein the third material comprises a precursor of a rare earth metal oxide.

76. An article, comprising:

a substrate having a surface with a root mean square roughness of at least about 100 nanometers;

a layer of a first material supported by the surface of the substrate, the layer of the first material having a textured surface; and

an epitaxial layer of a second material supported by the textured surface of the layer of the first material.

77. The article of claim 76, wherein the first material comprises an amorphous material.

78. The article of claim 76, wherein the first material is disposed on the surface of the substrate.

79. The article of claim 76, wherein the first material comprises a buffer layer material.

80. The article of claim 76, wherein the epitaxial layer is disposed on the textured surface of the layer of the first material.

81. The article of claim 76, wherein the second material comprises a buffer layer material.

82. The article of claim 76, wherein the second material is selected from the group consisting of superconductor materials and precursors of superconductor materials.

83. The article of claim 82, wherein the article has a critical current density of at least about 5 x 10^5 Amperes per square centimeter.

84. The article of claim 76, wherein the second material is selected from the group consisting of YBCO and precursors of YBCO.

85. The article of claim 84, wherein the article has a critical current density of at least about 5 x 10^5 Amperes per square centimeter.

86. An article, comprising:

a substrate having a surface with a root mean square roughness of at least about 100 nanometers; and

a layer of a superconductor material supported by the surface of the substrate,

wherein the article has a critical current density of at least about 5 x 10^5 Amperes per square centimeter.

87. The article of claim 86, wherein the article has a critical current density of at least about 1x 10^6Amperes per square centimeter.

88. The article of claim 86, wherein the layer of the superconductor material is biaxially textured.

89. The article of claim 86,wherein the layer of the superconductor material is c-axis out of plan and biaxially textured in plane.

90. The article of claim 86, further comprising a layer of a second material disposed between the substrate and the layer of superconductor material.

91. The article of claim 90, wherein the layer of the second material has a textured surface that supports the layer of the superconductor material.

92. The article of claim 91, wherein the layer of the superconductor material is disposed on the textured surface of the layer of the second material.

93. The article of claim 92, wherein the second material comprises a buffer layer material.

94. The article of claim 92, wherein the second material is chemically compatible with the superconductor material.

95. The article of claim 90, further comprising a layer of a third material disposed between the layer of the second material and the layer of the superconductor material.

96. The article of claim 95, wherein the layer of the third material is chemically compatible with the superconductor material.

97. A system, comprising:

a first ion beam source capable of emitting a first ion beam; and

a second ion beam source capable of emitting a second ion beam,

wherein the first and second ion beam sources are positioned so that when they emit the first and second ion beams, respectively, to impinge on a surface to texture the surface, the first ion beam is disposed at a first angle relative to a perpendicular to the surface and the second ion beam is disposed at a second angle relative to the perpendicular to the surface, and the first and second ion beams are disposed relative to each other at a third angle so that a crystal plane of the textured surface is oriented perpendicular to the textured surface.

98. The system of claim 97, wherein the third angle is about 90°.

99. The system of claim 97, wherein the first angle is different than the second angle.

100. The system of claim 97, further comprising a third ion beam source capable of emitting a third ion beam.

101. The system of claim 100, wherein the third ion beam source is positioned so that when it emits the third ion beam to impinge on the surface to texture the surface, the third ion beam is disposed at a fourth angle relative to the perpendicular to the surface, and the first and third ion beams are disposed relative to each other at a fourth angle so that a crystal plane of the textured surface is oriented perpendicular to the textured surface.

102. The system of claim 101, further comprising a fourth ion beam source capable of emitting a fourth ion beam.

103. The system of claim 102, wherein the fourth ion beam source is positioned so that when it emits the fourth ion beam to impinge on the surface to texture the surface, the fourth ion beam is disposed at a fifth angle relative to the perpendicular to the surface, and the fourth and third ion beams are disposed relative to each other at a sixth angle so that a crystal plane of the textured surface is oriented perpendicular to the textured surface.

104. The system of claim 100, further comprising a fourth ion beam source capable of emitting a fourth i

105. A system, comprising:

first ion beam means for emitting a first ion beam; and

second ion beam means for emitting a second ion beam,

wherein the first and second ion beam means are positioned so that when they emit the first and second ion beams, respectively, to impinge on a surface to texture the surface, the first ion beam means is disposed at a first angle relative to a perpendicular to the surface and the second ion beam means is disposed at a second angle relative to the perpendicular to the surface, and the first and second ion beams are disposed relative to each other at a third angle around the perpendicular to the surface so that a crystal plane of the textured surface is oriented perpendicular to the textured surface.

106. The system of claim 105, wherein the third angle is about 90°.

107. The system of claim 105, wherein the first angle is different than the second angle.

108. The system of claim 105, further comprising third ion beam means capable of emitting a third ion beam.

109. The system of claim 108, wherein the third ion beam means is positioned so that when it emits the third ion beam to impinge on the surface to texture the surface, the third ion beam is disposed at a fourth angle relative to the perpendicular to the surface, and the first and third ion beams are disposed relative to each other at a fourth angle around the perpendicular to the surface so that a crystal plane of the textured surface is oriented perpendicular to the textured surface.

110. The system of claim 109, further comprising fourth ion beam means capable of emitting a fourth ion beam.

111. The system of claim 110, wherein the fourth ion beam means is positioned so that when it emits the fourth ion beam to impinge on the surface to texture the surface, the fourth ion beam is disposed at a fifth angle relative to the perpendicular to the surface, and the fourth and third ion beams are disposed relative to each other at a sixth angle around the perpendicular to the surface so that a crystal plane of the textured surface is oriented perpendicular to the textured surface.

112. The system of claim 108, further comprising a fourth ion beam means capable of emitting a fourth ion beam.